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Learning objects: Conditions for viability

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Abstract

This article elaborates the factors that have led to the emergence of the concept of learning objects as the predominant model for digital learning materials, examining the problems that they address. It suggests that while there do appear to be real benefits, for a learning object model to be successful there needs to be a thriving learning object economy. In turn this demands a wide group of authors, drawn from the teaching community, and for these to participate there is an urgent requirement for tools that permit the easy creation and description of learning materials in learning objects format; but more importantly, support for sustainable communities of authors of digital learning materials.

Keywords

Learning object, interoperability standards, courseware, resource-based learning

Introduction

Since the advent of micro-computing in the 1980s, computer-based learning materials have promised to enhance the materials traditionally used in education – text books. However the uptake of computer-based content has not been as great as expected. The reasons given for this failure include that they rapidly become unusable as technology evolves, that it is too difficult to adapt these materials to teachers' specific contexts, and that they are too expensive to produce. The learning object model promises to resolve these problems by embracing interoperability standards, by being highly

customisable and by virtue of its component model, allowing the reuse of learning objects.

This paper suggests that the main obstacles lie elsewhere, and concern the lack of understanding of teachers' issues and working practices. It elaborates how teachers have in the past used available technologies such as copying machines to create materials in order to give them greater pedagogic flexibility, and how it was hoped that early computer-based materials would enhance this further. However the production models adopted by commercial producers failed to recognise teachers' realities, producing large chunks of inadaptable content. A reusable learning object model represents a move away from this approach, but in order to create a large base of learning objects high level of participation is required from teachers acting as authors. To do this they need high quality tools, but most importantly it is necessary to fund the establishment and maintenance of communities of teacher/authors who will both create and consume materials.

Teachers' requirements for materials to be contextualised into sharable lesson plans and course plans is discussed, and how the IMS Learning Design specification may help with this. But the paper concludes that while learning objects represent a significant technological advance, this may be insufficient for them to succeed, and that state funding should be focused less on projects to develop specific materials, and more on the building and sustaining of communities of teachers acting as authors and users of learning objects.

Background

From its early beginnings a major focus of computer based learning development has been on the creation of learning content, adding new dimensions to the presentation and interactive possibilities of learning material. The promise of computer based content led to several large initiatives to create databases of (largely teacher developed) materials – the National Educational Resources Information Service (NERIS) in the 1980s, the Teaching and Learning Technology Programme (TLTP) in the 1990s, and more recently the National Learning Network (NLN), to mention only a few – each costing several millions of pounds. Yet most would agree that despite this large investment, there is poor uptake of computer based materials. Several explanations can be offered for this:

1. Learning materials often have a short shelf life; technologies move on, and materials written to run on a particular platform may not survive generational changes in technical systems
2. They do not travel well – teachers like to adapt materials to suit the way they want to present course content.
3. New learning content is expensive to produce and duplication of existing materials should be avoided, reusing them wherever possible.

A classic example of the first point is the BBC Domesday project, a huge resource developed by the BBC and stored on a video disc – but in a format that is no longer supported by any current platform, requiring outdated technology to read it. A recent project led by the University of Leeds has rescued the data at some cost and has converted it to a "standardised" format which will hopefully have more longevity (Camileon 2004). This problem, of producing materials that conform to a common

standard that can survive technology change, is being tackled by initiatives to define interoperability standards for digital content (IMS 2004a). In turn this has spurred on efforts to create formal definitions for what is meant by learning content, to which learning objects offer an answer.

Learning objects also offer potential solutions to the second and third points, concerning adaptability and reusability. This is elaborated in some detail later, but first it is necessary to reflect on the teaching and learning context, how learning materials have been traditionally created, and what early computer-based materials promised to make possible. In particular it is important to consider what has motivated teachers to engage in searching for and creating content beyond course text books.

Typically, teachers work in a well defined context in their schools, colleges and universities. There is usually a detailed curriculum, providing syllabuses for subject-based courses (in the main) on which teachers base their lesson plans. These typically involve the sequencing of concepts and information at all levels (curriculum, syllabus and lesson plan), which represents the pedagogic preferences of the teacher or the course designers. Lesson plans often include presentations by the teacher, learning materials and texts, exercises, and so on. Some of these materials might come from published texts, others may be written by the teacher. In some situations teachers will base their teaching on a single text book, using the suggested sequence within the book, in others they will use varied resources, but almost always amplifying and extending the material with their own explanations and interpretations.

Course text books usually emerge when the teaching of a subject has reached stability, or when there is a sufficiently large market for a subject at a particular level. They are often written by teachers who have taught a course successfully, and are based on their pedagogical ideas. They provide ideas and concepts in a particular order, elaborated in specific ways, and often suggest exercises and activities that may further promote understanding – they embody the pedagogy of the authors. This is an important point – they are not just reference books. Successful text books, those that reach a wide market are those that are most able to transcend the teaching contexts on which they are based; in other words, they embody a pedagogic approach that is acceptable to a wide group of teachers or course providers. However, these approaches are mediated, adapted or sometimes transformed by the teacher, as described earlier. Quality control with regards to accuracy and accessibility (and sometimes pedagogic preferences) is handled by publishers, who regulate access to authorship, review and promotion.

Until the 1960s the text book was the main means by which learning materials were created and distributed, and to a large extent, this approach continues to dominate. Since then, however, new technologies began to offer opportunities to extend and transform how materials could be made and used. Access to low cost duplication technologies – from spirit copiers to photocopiers – made it possible for teachers to create materials for their classes, and thereby to extend and adapt the offering in course text books.

Access to authoring gave teachers experience in the design and creation of learning materials, and also made it possible for new methods in teaching and learning to

emerge and be realised. It had always been evident that in any class there was a range of learning needs, and that the course text book suited some better than others. In the 1960 and 1970s some teachers and educationalists were concerned about the effects of streaming on children's self esteem, and searched for pedagogical methods that permitted individual learning in so-called informal and mixed ability settings (Smith 2002). Resource based learning was seen as a possible solution, making use of a range of resources – work-cards, work-sheets, investigations, experiments, and so on – that could be given to small groups or individual learners according to their abilities and aptitudes. Resource based learning was made possible by easier access to authoring technologies, and usually began as local initiatives that sometimes became regional or national schemes.

The resource-based learning approach, making use of small units of resource to assemble individualised learning programmes, has much in common with the learning object approach, supporting reusability, aggregation and customisation. It allows greater flexibility in the construction of learning programmes, but makes the role of teacher as interpreter/explainer more difficult, since more of their time is spent in the allocation of resources to individuals. When micro-computing arrived in the 1980s, it was seen by many as extending the resource-based learning model with new media – multimedia, hypermedia, simulations, micro-worlds and so on. However, as has been suggested earlier in this paper, online content was not immediately as successful as was first anticipated. Despite its great promise, online content did not sell well. There was too little equipment in schools, and content was locked into proprietary formats. But most significantly, publishers of early computer based materials went for the text book model instead of the small, reusable content model. They needed mass sales of

significant chunks of material to be profitable, and as was stated earlier, large chunks of inadaptable material do not travel well.

There were initiatives (already referred to) during the pre-internet period to get teachers involved in developing and exchanging materials, but these failed to attract enough contributors to maintain an ongoing exchange; because funding was focused on creation of materials but not on sustaining a learning materials economy, these tended to have a short life. The lack of technical standards also resulted in materials becoming inaccessible after a while (how many Hypercard stacks or Toolbook packages are still in use?)

The arrival of the World Wide Web and internet technologies provided another impetus for online learning. Access to materials became easier as the internet spread; content standardisation at a basic level was addressed with basic standards like HTML, GIF and JPEG. The prevailing paradigm in software development, object-oriented programming, provided new concepts for thinking about the creation of online content, which resulted in the emergence of the concept of learning objects.

Learning Objects

The term "learning object" has been around for a decade or longer, the earliest use of the term probably being by Wayne Hodgins in the title of the CedMA working group called "Learning Architectures, APIs, and Learning Objects" (Wiley 2002). The term has gained currency in recent years to the extent that there have been related

standardisation efforts that have sought to provide a formal definition. The IEEE working group on Learning Object Metadata (LOM) provided a working definition:

> *IEEE Learning Objects are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. Examples of technology-supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. Examples of Learning Objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning (LOM, 2000).*

So, anything can be a learning object! While the spirit of this definition may be laudable, this is so broad that it is not useful for discussions centred on eLearning content. David Wiley offers a narrower definition:

> *"any digital resource that can be reused to support learning." (ibid p.6)*

This is still very broad – it limits learning objects to digital resources, but does not say anything about the intrinsic nature of learning objects. To confuse matters, various vendors offer their own definitions, all of which differ in small ways. (e.g. NetG and Toolbook). There are also Merrill's knowledge objects, a related term (Merrill 1999).

Most people involved in the creation of learning material standardisation efforts agree that learning objects must have the following properties:

1. They have to be able to be searched for – they must have metadata
2. They can be assembled from other learning objects –implying that there are both basic and compound objects.
3. They have a learning objective (although this raises the question as to who defines the learning objective – the author, the cataloguer, the teacher or the learner?)

It can be seen that "learning object" is a relatively new term that is still immature and is yet to achieve a consistent definition. However, the slow rate of uptake of computer-based learning materials, and the identified problems of adaptability and reusability have led those involved in computer based learning to look to learning objects for solutions, in the expectation that a common-sense definition will emerge through practice.

According to one of the originators of the term, learning materials of the future will be assembled in a Lego-like fashion from smaller objects (Hodgins 2000). Components will be easily added, removed or replaced making them highly adaptable. These small components will be as valuable as the assembled materials, and will be easily reused in other learning materials. Proponents of learning objects argue that because of their adaptability and their support for reuse, they represent a major step forward for computer based learning content, and evidence of confidence in the learning object approach can be seen in the drive for specifications for learning object interoperability standards led by the Advanced Distributed Learning Initiative (ADL) in the US and

implemented by the IMS global consortium. These specifications, elaborated in detail elsewhere (e.g. see Olivier and Liber 2003) address how learning objects should be described (metadata), packaged (assembled) into larger units of content and sequenced to provide navigation paths. These along with another specification for tracking learners in their use of learning objects form the basis of SCORM, ADL's Shareable Content Object Reference Model, which defines the standard that the US government insists upon for the learning materials it commissions. With these specifications and standards in place materials built from learning objects can be reused and adapted to different contexts.

Supporting Technologies

Producing materials in small learning object format requires additional effort from authors, to make sure each object conforms the requirements of interoperability standards – description, searchability, aggregation and disaggregation. If teachers are to become learning object authors, they need tools that make this as easy as possible, supporting the creation of the media assets, the assembly, sequencing and packaging of these, and the description of the objects (metadata tagging). Providing these facilities is a major challenge. Authoring systems to date (like Hypercard, Toolbook, Director and others) result in proprietary files that combine both the media assets and navigation information. For learning objects to be aggregable and disaggregable, these must be distinguished. Materials have to be assembled that keep structure and navigation information separate from media.

A few tools exist that support this (e.g. RELOAD 2004) and are being extended to provide support for lesson planning; but at present they are still quite technical and

require some personal investment by the user. Adding metadata is an overhead for someone creating materials, and more work is needed to make this as simple as possible to encourage authors to do so. Working in an object-oriented way is not natural for teachers or authors when creating learning material, who would naturally focus on a lesson or a course as the basic unit. Tools that facilitate the extraction of objects from courseware are needed, that help authors to disaggregate their materials into objects. These objects need to be easily publishable, and be made available via repositories that can be searched more effectively than existing search engines allow. These repositories may be centralised or peer-to-peer, depending on the requirements of the authoring community. Complicated issues concerning copyright and intellectual property should not concern teachers, and need to be addressed in a way that allows exchange to flourish. These problems are being addressed, and in the UK, significant funding is being put into the establishment of repositories of learning objects (e.g. the JISC funded Jorum+ project and the DfES funded NLN).

The last few years have seen large investment in the development of interoperability standards and tools that permit their implementation. These initiatives address the technical issues that prevent adaptability and reusability, but the fundamental problem for the creation and maintenance of resource based learning is not technical. The demand for flexible resources emerges from communities of teachers committed to particular pedagogical approaches, and these communities need to be empowered, supported and rewarded. Educational, social and economic factors are fundamental issues for the creation of a sustainable digital content economy..

A community approach to content creation

A good model for a community of learning object authors is a project that involved a large group of teachers within the Inner London Education Authority (ILEA) that in the 1970s developed the Secondary Maths Individualised Learning Experiment (SMILE). Originally self-organised with a mission to tackle what they saw as an inadequate model of mathematics teaching, they convinced the LEA to fund their release from some of the teaching duties to create a large resource base. In the first few years of the project they produced some 2000 resources, mainly workcards and worksheets but also games, puzzles and some computer based materials, and devised a scheme for managing how these resources could be selected and packaged for children, involving test books, answer books and management instruments. With the support of the ILEA the project thrived, running annual conferences, publishing a newsletter and providing support from the funded SMILE Centre. At its peak around half of London schools were using the scheme, and for a decade the SMILE community grew and the resource base developed and was refined. However, with the demise of the ILEA in 1988, the SMILE Centre and ownership in the materials was passed to the Royal Borough of Kensington and Chelsea, and a commercial publishing model was adopted. Although the SMILE Centre has tried to maintain community involvement, participation has declined, and the spirit that made SMILE such a dynamic project for a decade has all but gone (SMILE 2003).

The SMILE experience demonstrated what can be possible when the understanding of educational problems is shared by teachers and those controlling resources. SMILE was not imposed as a top-down solution to a problem identified by management, but arose from the teachers' analysis of the problem shared by the LEA, and was sustained for as long as teachers maintained this shared view, and were supported by

funding to engage in providing a solution. Both of these were essential. As soon as ownership of the SMILE project perceived as having been taken from teachers, it lost its dynamism. Oliver (2003) discusses how changes in practice in university teaching is more likely to emerge from academics developing shared meaning by engaging with each other and other stakeholder groups, than it is if management attempts to impose its understanding on them; but to make the significant change in practice that the creation of a learning object economy requires take place demands financial support at least in the initial phases, or until normal practice assumes participation in the activities of this economy.

The key problem that faces those that seek to promote a learning object economy is that a large community of authors is needed to build and maintain a viable base of objects. Communities need building, nurturing, and rewarding, much as the SMILE project was in its heyday. However most state funding is targeted at content production with little regard for sustainability beyond the authoring stage. Even if it is accepted that learning objects represent the best technical way to create learning materials, adopting this approach is by itself no guarantee of success.

There are other suggestions that have been made that may encourage the development of a learning object economy. One is the idea of micro-payment, where authors can be paid every time their material is accessed (e.g. see Cox 1996). However micro-payment is yet to be implemented anywhere, and the accounting software overhead may be prohibitive. Building self-sustaining but supported communities of teacher-authors may be the best hope. For example, as well as funding centres like the Learning and Teaching Support Network (LTSN) centres, funding could be made

available to release practicing teachers and lecturers from part of their teaching to collaborate in the development of learning object resource bases. The UK Universities and Colleges Joint Information Systems Committee (JISC), through its Exchange for Learning (X4L) programme (2004), has funded a few projects that involved teachers from collaborating institutions to develop learning object based materials, but these will be short lived; more sustained funding for the ongoing support and maintenance of communities of teacher/authors is needed. Koper et al (2004) discuss the policy management, information and training issues in establishing community approaches to learning object development; but in the end, they need to be funded, and it may be that it is time that agencies shift their focus from funding projects to funding people.

Creating a Context for Learning Objects

Basing all materials on learning objects only addresses a part of what teachers need from learning technology. Teachers need help with thinking about how to present whole courses, with how to prepare successful lesson plans, as well as access to materials that they can use as part of their lessons – and this is as true for online learning as classroom based learning. Accessing content will always only be a part of the whole learning experience, and they way in which content is used in different context varies widely. Learning objects promise materials that are to some extent customisable, and in this regard may be a positive development; but the success of e-learning only depends in part on learning materials. Learners and teachers need to be able to engage in a range of activities, interacting with each other in many ways, questioning, arguing, exploring, simulating, evaluating –and not just presenting and

consuming content. Learning objects depend as much on the widespread use of eLearning as vice-versa.

Fortunately, there has been significant work on addressing the questions raised. Based on the Educational Modelling Language (EML) from the Open University of the Netherlands (Koper 2001), a specification for interoperability standards for the Learning Design has been created by IMS (IMS 2004b). This provides a language for describing learning activities, or to put it simply, lesson plans. It promises to support most pedagogic approaches, and was developed to include scenarios with multiple learners (i.e. most traditional learning contexts), which content based models tend to ignore. It includes standardised representations for roles people may play in learning situations, for actions they need to take and for tools, content and services that may be involved. Although the aim of the Learning Design Specification is to make it possible for conformant Virtual Learning Environments (VLEs) to support richer educational activities and be able to exchange these with other VLEs, it also permits the design and description of learning activities at multiple levels – the lesson, the module and so on. It provides a context for content to be located, blending the use of content with other activities – group work, discussions, role plays etc. Learning objects become far more useful in this situation, permitting, for example, teachers to reuse learning designs but with different content. However, this is still a very young specification, and requires friendly tools to make it useful, and widespread adoption by learning environment developers.

Success factors

This paper has focused on the relevance of learning objects to traditional education – schools, colleges and universities – and it has been suggested that on their own, simply making learning materials from learning objects will not make sufficient difference to ensure success. But there are other contexts – vocational training and informal learning, the two components of life long learning. Are learning objects useful in these contexts? One can imagine that in a training context there may be certain small topics for which a single learning object might be useful, and that this learning object could be reused in different training packages. This could be useful for training providers, allowing them to reuse components as they develop packages for different clients. In informal, interest-based learning situations, the ability to find learning objects that address discrete aspects of the subject being pursued would be very useful; but again, it is important to understand these learning contexts well. Finding a learning object might be just the beginning for an informal learning experience, which may involve finding others with the same interest, forming learning groups, and a range of other social interactions. In these social situations, having content "on tap" can be very useful – indeed, Stephen Downes (2004) believes that we need to think of online content as being like water or electricity – and a thriving learning object economy can make this possible. There is no doubt that learning objects can play an important role in helping the learning potential of the Internet become reality, but a model for the creation of a learning object economy is still lacking. Who will be the learning object creators? What will be the advantage for them to make their materials as learning objects? How will they be rewarded for this? How will learning objects be consumed, and by whom? Institutions? Teachers? Learners? In which contexts, and how will they pay for them (if at all)? These are

huge questions, and while a learning object economy may be pump primed by state investment, this does not guarantee long term sustainability.

Conclusions

Learning objects provide the current paradigm for the creation of digital learning material, and as such provide major benefits over the monolithic, large pieces of courseware developed in proprietary format. By having learning materials in small, technically interoperable format, they can be assembled into large pieces of content, and be reused in many of these. Technical standards are now available for learning object creation, and tools to support their creation and distribution are becoming available. However for this approach to become a success, a number of other challenges need to be addressed. A large base of learning objects is needed to demonstrate the benefits of reusability, which in turn requires a huge authoring effort. Teachers should form a major part of the authoring community, but need easy to use tools to reduce the overhead that authoring in learning object format creates. They also need to be able to exchange designs for lessons and courses that incorporate learning objects – teachers are likely to be more interested in sharing ideas for lessons and courses than just materials. Most importantly, it is suggested that instead of just funding the creation of specific materials, some resource should be provided to sustain authoring communities, to motivate and support teachers to participate in the creation, maintenance and exploitation of learning resources. Without supporting people in this activity, learning objects may be yet another failed effort to make digital content realise its potential; but if a holistic approach is taken to addressing technical, educational, social and economic factors, learning objects can have a major impact on the success of eLearning.

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